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6 May 2004

The International Bureau of WIPO
34 Chemin des Colombettes
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Switzerland

"Amendment of the claims under Article 19(1) (Rule 46)"

Re: International Application No. PCT/JP03/12864
Applicant: Matsushita Electric Industrial Co., Ltd.
Agent: IKEUCHI SATO & PARTNER PATENT ATTORNEYS
International Filing Date: 8 October 2003
Our Ref.: H1826-01

Dear Sirs:

The Applicant, who received the International Search Report relating to the above-identified International Application transmitted on 9 March 2004, hereby files amendment under Article 19(1) as in the attached sheets.

The applicant hereby cancels (sheet No.50-52) entirely. Thus claims 1, 2 and 7-12 have been amended, claims 3-6 have been cancelled and claims 13-15 have been added.

Sincerely yours,

Hiroyuki Ikeuchi

IKEUCHI SATO & PARTNER PATENT ATTORNEYS
Representative Partner
Hiroyuki IKEUCHI

Attachment:
Amendment under Article 19(1) 5 sheets

REPLACE by #19

CLAIMS

1. An optical head, comprising:

a light source for radiating laser light;

an objective lens for focusing the laser light that is radiated from the light source onto an information recording medium;

light splitting means for spatially dividing the laser light that is reflected by the information recording medium and that passes through the objective lens into a plurality of light fluxes;

a light receiving element for receiving the plurality of light fluxes divided by the light splitting means;

tracking error signal detection means for detecting a tracking error signal based on the plurality of light fluxes received by the light receiving element; and

spherical aberration detection means for detecting spherical aberration that occurs at the objective lens, based on the plurality of light fluxes received by the light receiving element;

wherein the light splitting means has six regions that are divided by a first splitting line that is substantially parallel to a longitudinal direction of an information track formed on the information recording medium, and second and third splitting lines arranged in parallel that are substantially perpendicular to the first splitting line, and that are substantially symmetrical about the optical axis of the focusing optical system;

wherein the tracking error signal detection means generates the tracking error signal by calculating signals detected by receiving light fluxes created by laser light passing through those two of the six regions that are disposed between the second and third splitting lines, and generates a signal for correcting the offset of the tracking error signal caused by movement of the objective lens by calculating signals detected by receiving light fluxes created by laser light passing through those four of the six regions that are disposed on the outer side of the second and third splitting lines; and

wherein the spherical aberration detection means compares a first focal point shift amount obtained by detecting the size of a light spot formed by focusing the light fluxes created by laser light passing through two regions that are disposed between the second and third splitting lines, onto the light receiving element, and a second focal point shift amount obtained by detecting the size of a light spot formed by focusing the light fluxes

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created by laser light passing through the four regions, which are disposed on the outer side of the second and third splitting lines onto the light receiving element, to generate a spherical aberration error signal for detecting the spherical aberration generated at the objective lens.

2. The optical head according to claim 1, further comprising tilt detection means for detecting the relative inclination between the objective lens and the information recording medium,

wherein the interval between the second and third splitting lines is narrower than the width, in the longitudinal direction of the information track of the information recording medium, of the region in which 0-order light and ± 1-order light that are diffracted at the information track of the information recording medium are superimposed; and

wherein the tilt detection means compares the phase of a first tracking error signal obtained by calculating signals detected by receiving light fluxes created by laser light passing through the two regions that are disposed between the second and third splitting lines, and of a second tracking error signal obtained by calculating signals detected by receiving light fluxes created by laser light passing through the entire region of the light splitting means, to generate a tilt error signal for detecting the relative inclination between the objective lens and the information recording medium.

3. An optical head, comprising:

a light source for radiating laser light

an objective lens for focusing the laser light that is radiated from the light source onto an information recording medium;

light splitting means for spatially dividing the laser light that is reflected by the information recording medium and that passes through the objective lens into a plurality of light fluxes;

a light receiving element for receiving the plurality of light fluxes divided by the light splitting means;

tracking error signal detection means for detecting a tracking error signal based on the plurality of light fluxes received by the light receiving element; and

spherical aberration detection means for detecting spherical aberration that occurs at the objective lens, based on the plurality of light

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fluxes received by the light receiving element;

wherein the light splitting means has eight regions that are divided by a first splitting line that is substantially parallel to the longitudinal direction of the information track formed on the information recording medium, a second splitting line that is substantially perpendicular to the first splitting line and that passes through the optical axis of the objective lens, a third splitting line that is substantially parallel to the second splitting line and a semicircle-shaped fourth splitting line that is on the other side of the third splitting line to the second splitting line, and that is centered on the optical axis of the focusing optical system;

wherein the tracking error signal detection means generates the tracking error signal by calculating signals detected by receiving light fluxes created by laser light passing through those two of the eight regions that are disposed between the second and third splitting lines, and generates a signal for correcting the offset of the tracking error signal caused by movement of the objective lens, by calculating signals detected by receiving light fluxes created by laser light passing through those two of the eight regions that are disposed on the outer side of the third splitting lines; and

wherein the spherical aberration detection means compares a first focal point shift amount obtained by comparing the quantity of light detected on a first light receiving region and a second light receiving region by focusing the light fluxes created by laser light passing through the two regions enclosed by the second splitting line and the fourth splitting line, onto the splitting line of the first light receiving region and the second light receiving region formed on the light receiving element, and a second focal point shift amount obtained by comparing the quantity of light detected on a third light receiving region and a fourth light receiving region by focusing the light fluxes created by laser light passing through the two regions on the outer side of the fourth splitting line, onto the splitting line of the third light receiving region and the fourth light receiving region formed on the light receiving element, to generate a spherical aberration error signal for detecting the spherical aberration generated at the objective lens.

4. The optical head according to claim 4, further comprising tilt detection means for detecting the relative inclination between the objective lens and the information recording medium,

wherein the interval between the second and third splitting lines is

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narrower than half the width, in the longitudinal direction of the information track of the information recording medium, of the region in which 0-order light and ±1-order light that are diffracted at the information track of the information recording medium are superimposed; and

wherein the tilt detection means compares the phase of a first tracking error signal obtained by calculating signals detected by receiving light fluxes created by laser light passing through two regions that are disposed between the second and third splitting lines, and of a second tracking error signal obtained by calculating signals detected by receiving light fluxes created by laser light passing through the entire region of the light splitting means, to generate a tilt error signal for detecting the relative inclination between the objective lens and the information recording medium.

5. An optical head, comprising:

a light source for radiating laser light

an objective lens for focusing the laser light that is radiated from the light source onto an information recording medium;

light splitting means for spatially dividing the laser light that is reflected by the information recording medium and that passes through the objective lens into a plurality of light fluxes;

a light receiving element for receiving the plurality of light fluxes divided by the light splitting means;

tracking error signal detection means for detecting a tracking error signal based on the plurality of light fluxes received by the light receiving element; and

spherical aberration detection means for detecting spherical aberration that occurs at the objective lens, based on the plurality of light fluxes received by the light receiving element;

wherein the light splitting means has eight regions that are divided by a first splitting line that is substantially parallel to the longitudinal direction of the information track formed on the information recording medium, second and third splitting lines arranged in parallel that are substantially perpendicular to the first splitting line and are substantially symmetrical about the optical axis of the objective lens, and a fourth splitting line that is circular, positioned between the second and third splitting lines and centered on the optical axis of the focusing optical system;

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wherein the tracking error signal detection means generates the tracking error signal by calculating signals detected by receiving light fluxes created by laser light passing through those two of the eight regions that are disposed on the outer side of the fourth splitting line and between the second and third splitting lines, and generates a signal for correcting the offset of the tracking error signal caused by movement of the objective lens, by calculating signals detected by receiving light fluxes created by laser light passing through four regions, of the eight regions, that are disposed on the outer side of the second and third splitting lines; and

wherein the spherical aberration detection means compares a first focal point shift amount obtained by detecting changes in the shape of a light spot that is focused on the light receiving element by applying an astigmatism to light fluxes created by laser light passing through a region on the inner side of the fourth splitting line, and a second focal point shift amount obtained by detecting changes in the shape of a light spot that is focused on the light receiving element by applying an astigmatism to light fluxes created by laser light passing through the entire region of the light splitting means, to generate a spherical aberration error signal for detecting the spherical aberration generated at the objective lens.

6. The optical head according to claim 5, further comprising tilt detection means for detecting the relative inclination between the objective lens and the information recording medium,

wherein the interval between the second and third splitting lines is narrower than the width, in the longitudinal direction of the information track of the information recording medium, of the region in which 0-order light and ± 1-order light that are diffracted at the information track of the information recording medium are superimposed; and

wherein the tilt detection means compares the phase of a first tracking error signal obtained by calculating signals detected by receiving light fluxes created by laser light passing through two regions that are disposed on the outer side of the fourth splitting line and between the second and the third splitting lines, and of a second tracking error signal obtained by calculating signals detected by receiving light fluxes created by laser light passing through the entire region of the light splitting means, to generate a tilt error signal for detecting the relative inclination between the objective lens and the information recording medium.

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7. The optical head according to any one of claim 1, 3 and 5,

wherein the signal indicating the first focal point shift amount is SAE1, and the signal indicating the second focal point shift amount is SAE2, and the spherical aberration error signal SAE is expressed by:

$SAE = SAE2 - k \times SAE1$,

(where k is a constant that substantially satisfies $k = SAE2 / SAE1$ when there is no spherical aberration and when the focal point shift amount is within a predetermined range).

8. The optical head according to any one of claim 1, 3 and 5,

wherein the light splitting means includes a polarizing hologram.

9. The optical head according to any one of claim 1, 3 and 5,

wherein the light receiving element is an integrated light receiving/emitting element that is configured as a single unit with the light source.

10. The optical head according to any one of claim 1, 3 and 5,

wherein the light receiving element is an integrated optical element in which the light source and the light splitting means are configured as a single unit.

11. The optical head according to any one of claim 1, 3 and 5, further comprising:

a liquid crystal element provided between the objective lens and the light splitting means, and

spherical aberration correction means for correcting the spherical aberration by changing the phase of wavefronts that pass through the liquid crystal element due to the application of a voltage in accordance with the spherical aberration error signal created by the spherical aberration detection means.

12. An optical disk device, comprising:

an optical head according to claim 7, and

a control circuit for adding an electrical offset to a focus error signal to create a predetermined focal point shift, and determining the constant k

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such that the fluctuations of the spherical aberration error signal SAE = SAE2 – k × SAE1 in a range of the predetermined focal point shift are contained within a predetermined range.